

CLAIMS

What is Claimed is:

1. An implantable cardiac stimulation device comprising:
- 5 a first sensor that is capable of sensing intrinsic cardiac activity and generating corresponding signals;
- circuitry that is connected to the sensor to receive signals from the sensor, wherein the circuitry is operative to process the signals to determine an intrinsic heart rate;
- 10 a second sensor that is capable of sensing a physiologic parameter;
- circuitry that is connected to the second sensor and that is operative to determine a potential sleep apnea condition based on the sensed physiologic parameter;
- 15 one or more pulse generators that are capable of generating cardiac pacing pulses to be delivered to the patient; and
- a control circuit that is responsive to detection of the potential sleep apnea condition to control the one or more pulse generators to pace at an overdrive pacing rate based on the intrinsic heart rate.
- 20
2. An implantable cardiac stimulation device according to Claim 1 wherein the control circuit comprises an executable control logic that includes a logic capable of detecting a sleep condition, and a logic
- 25 capable of controlling the one or more pulse generators with a timing based on the sensed intrinsic cardiac electrical phenomena to overdrive the intrinsic cardiac electrical phenomena to prevent sleep apnea.
3. An implantable cardiac stimulation device according to Claim 1
- 30 wherein the control circuit comprises an executable control logic that detects a sleep apnea condition and controls the one or more pulse

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generators with a timing based on the sensed intrinsic cardiac electrical phenomena and is capable of terminating the detected sleep apnea condition.

- 5 4. An implantable cardiac stimulation device according to Claim 1 wherein the control circuit comprises an executable control logic including a logic for detecting a sleep condition based on the physiological parameter, and a logic capable of controlling the one or more pulse generators with a timing based on the sensed intrinsic cardiac electrical phenomena to overdrive the intrinsic cardiac electrical phenomena to prevent sleep apnea.

- 15 5. An implantable cardiac stimulation device according to Claim 1 wherein the control circuit comprises an executable control logic that detects a sleep apnea condition based on the sensed physiological parameter and controls the one or more pulse generators with a timing based on the sensed intrinsic cardiac electrical phenomena that is capable of terminating the detected sleep apnea condition.

- 20 6. An implantable cardiac stimulation device according to Claim 6 wherein the abnormal breathing pattern is indicative of Cheyne-Stokes respiration.

- 25 7. An implantable cardiac stimulation device according to Claim 1 further comprising:

a sensor implantable into a chamber of the heart that is capable of sensing intrinsic electrical phenomena; and

a pulse generator of the one or more pulse generators that is capable of generating pacing pulses based on timing of the sensed intrinsic electrical phenomena to dynamically overdrive the intrinsic electrical phenomena, the generated

cardiac pacing pulses being capable of preventing sleep apnea.

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5 8. An implantable cardiac stimulation device according to Claim 1
wherein the control circuit comprises an executable control logic that is
capable of distinguishing between a rest or sleeping condition and a
waking condition of a patient based on the physiological parameter,
confirming a sleep apnea condition based on the physiological parameter,
and generating pacing pulses based on timing of the sensed intrinsic
10 cardiac electrical phenomena to dynamically overdrive the intrinsic
cardiac electrical phenomena, the generated cardiac pacing pulses being
capable of preventing sleep apnea.

15 9. An implantable cardiac stimulation device according to Claim 1
further comprising:
an impedance sensor that is capable of sensing one or more
respiration parameters; and
wherein the control circuit is coupled to the one or more pulse
generators and to the impedance sensor, the control circuit
20 comprising an executable control logic that is capable of
distinguishing between a sleeping condition and a waking
condition of a patient based on the one or more respiration
parameters, and generating pacing pulses based on timing
of the sensed intrinsic cardiac electrical phenomena to
25 dynamically overdrive the intrinsic cardiac electrical
phenomena, the generated cardiac pacing pulses being
capable of preventing sleep apnea.

30 10. An implantable cardiac stimulation device according to Claim 1
further comprising:
an oxygen sensor that is capable of measuring blood oxygen
concentration; and

wherein the control circuit is coupled to the one or more pulse
generators and to the impedance sensor, the control circuit
comprising an executable control logic that is capable of
detecting a sleep apnea condition of a patient based on a
blood oxygen concentration indicative that blood oxygen
level is depressed during sleep, and generating pacing
pulses based on timing of the sensed intrinsic cardiac
electrical phenomena to dynamically overdrive the intrinsic
cardiac electrical phenomena, the generated cardiac pacing
pulses being capable of terminating sleep apnea.

11. An implantable cardiac stimulation device according to Claim 1
further comprising:

a carbon dioxide sensor that is capable of measuring blood carbon
dioxide concentration; and

wherein the control circuit is coupled to the one or more pulse
generators and to the impedance sensor, the control circuit
comprising an executable control logic that is capable of
detecting a sleep apnea condition of a patient based on a
blood carbon dioxide concentration indicative that blood
oxygen level is depressed during sleep, and generating
pacing pulses based on timing of the sensed intrinsic
cardiac electrical phenomena to dynamically overdrive the
intrinsic cardiac electrical phenomena, the generated
cardiac pacing pulses being capable of terminating sleep
apnea.

12. An implantable cardiac stimulation device comprising:

a sensor that is capable of sensing intrinsic cardiac electrical
phenomena;

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a heart rate determination device that is connected to the sensor
and is operative to determine an intrinsic heart rate based
on the sensed intrinsic cardiac electrical phenomena;
circuitry that is capable of generating cardiac pacing pulses at an
5 overdrive pacing rate based on the intrinsic heart rate; and
a sleep apnea determination device that is operative to determine
when a potential sleep apnea condition exists, and that is
responsive to the potential sleep apnea condition to control
the circuitry to generate pacing pulses at the overdrive
10 pacing rate.

13. An implantable cardiac stimulation device according to Claim
12 wherein the sleep apnea determination device comprises a controller
that comprises an executable control logic that includes a logic capable of
15 detecting a sleep condition, and a logic capable of controlling one or more
pulse generators with a timing based on the sensed intrinsic cardiac
electrical phenomena to overdrive the intrinsic cardiac electrical
phenomena.

20 14. An implantable cardiac stimulation device according to Claim
12 further comprising:
a physiological sensor that is capable of sensing a physiological
parameter; and
wherein the sleep apnea determination device comprises a
25 controller coupled to the sensor, the controller comprising an
executable control logic that detects a sleep apnea condition
based on the sensed physiological parameter and controls
one or more pulse generators with an overdrive pacing rate
based on the sensed intrinsic cardiac electrical phenomena.

30 15. An implantable cardiac stimulation device according to Claim
12 further comprising:

a physiological sensor that is capable of detecting an abnormal breathing pattern; and

wherein the sleep apnea determination device comprises a controller coupled to the physiologic sensor, the controller comprising an executable control logic that detects the abnormal breathing pattern and controls one or more pulse generators with a timing based on the sensed intrinsic cardiac electrical phenomena.

16. An implantable cardiac stimulation device according to Claim 15 wherein the abnormal breathing pattern is indicative of Cheyne-Stokes respiration.

17. An implantable cardiac stimulation device according to Claim 12 further comprising:

an impedance sensor that is capable of sensing one or more respiration parameters; and

wherein the sleep apnea determination device comprises a controller coupled to the impedance sensor, the controller comprising an executable control logic that is capable of detecting a sleep apnea condition of a patient based on the one or more respiration parameters, and generating pacing pulses based on timing of the sensed intrinsic cardiac electrical phenomena to generate overdrive pacing pulses.

18. An implantable cardiac stimulation device according to Claim 12 further comprising:

an oxygen sensor that is capable of measuring blood oxygen concentration; and

wherein the sleep apnea determination device comprises a controller coupled to the impedance sensor, the controller comprising an executable control logic that is capable of

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5 detecting a sleep apnea condition of a patient based on a blood oxygen concentration indicative that blood oxygen level is depressed during sleep, and generating pacing pulses based on timing of the sensed intrinsic cardiac electrical phenomena to dynamically overdrive the intrinsic cardiac electrical phenomena, the generated cardiac pacing pulses being capable of terminating sleep apnea.

10 19. A method of operating an implantable cardiac stimulation device comprising:
monitoring cardiac activity;
determining an intrinsic heart rate based on the monitored activity;
monitoring a physiologic parameter for a potential sleep apnea condition; and
15 generating overdrive pacing pulses at an overdrive pacing rate in response to determining a potential sleep apnea condition, wherein the overdrive pacing rate is based on the intrinsic heart rate.

20 20. A method according to Claim 19 further comprising:
detecting a sleep condition; and
generating the overdrive pacing pulses upon detecting the sleep condition.

25 21. A method according to Claim 19 further comprising:
detecting a sleep apnea condition; and
generating the overdrive pacing pulses upon detecting the sleep apnea condition.

30 22. A method according to Claim 19 further comprising:
detecting Cheyne-Stokes respiration; and

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generating the overdrive pacing pulses upon detecting the Cheyne-Stokes respiration.

23. A method according to Claim 19 further comprising:
5 sensing a physiological parameter;
distinguishing between a sleeping condition and a waking condition
of a patient based on the sensed physiological parameter;
generating cardiac pacing pulses based on timing of the sensed
intrinsic cardiac electrical phenomena; and
10 dynamically overdriving the heart.

24. An implantable cardiac stimulation device comprising:
means for determining an intrinsic heart rate;
means for detecting a potential sleep apnea condition; and
15 means for overdrive pacing the heart at a rate based on the
intrinsic heart rate in response to detection of a potential
sleep apnea condition.

25. An implantable cardiac stimulation device according to Claim
20 24 wherein the means for detecting a potential sleep apnea condition
comprises means for detecting a sleep condition.

26. An implantable cardiac stimulation device according to Claim
24 wherein the means for detecting a potential sleep apnea condition
25 comprises means for detecting a sleep apnea condition.

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